U.S.-China Clean Energy Cooperation: Status, Challenges, and Opportunities

Testimony before the U.S.-China Economic and Security Review Commission

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1. Describe the current and future projects you are working on.

The US-China Clean Energy Research Center—Clean Vehicle Consortium is jointly supported by the US Department of Energy and China Ministry of Science of Technology. The research projects of the center officially started in January 2011, and their focus is on developing and promoting clean vehicle technologies in the US and in China. The current work encompasses a comprehensive scope, combining systems analysis with key clean vehicle technologies, including vehicle electrification, energy storage and conversion, lightweight materials, grid integration and biofuels.

The first phase of the 5-year research center is scheduled to finish in about 2 years. For the next two years, we will focus on translating the research results to practice. This will be done by working closely with the Center's industrial members on selected subset of the research projects. The future direction of the Center is likely to continue on challenging bottleneck problems such as high energy density and reliably battery systems, lightweight materials and structures, and combine aspects of electrification with opportunities presented by connected vehicle technologies.

2. Are there economic or national security concerns associated with U.S.-China cooperation on clean energy? What about Chinese investment in U.S. clean energy/clean technology?

China and the United States are the two largest producers and consumers of primary energy sources, and the two largest automotive markets. Both countries invest heavily on technologies aiming to lower carbon foot-print and environmental impacts of ground transportation. It is mutually beneficial to leverage and coordinate the research and development work in these two countries to address the grand challenge related to energy sustainability and climate change.

The Chinese vehicle fleet continues to grow and with it the Chinese consumption of fossil fuels. The majority of U.S. OEM's have a significant presence in the Chinese market and continued collaboration between the U.S. and China will further support their efforts to expand in to this growing market. The Chinese automotive market is dominated by foreign or joint-venture brands. The top 6 brands are all foreign (VW, GM, Hyundai, Nissan, Ford and Toyota), with more than 50% market share. The top-selling Domestic (Chinese) brand, Great Wall, has less than 4% of the market. Winning the clean vehicle race helps the US companies to compete in the Chinese market. The Chinese auto makers currently are not competitive in clean vehicle technologies, including in Chinese and US markets.

3. To what extent is each country benefiting from the joint initiatives? Is the United States accruing benefits to the same extent as China?

While U.S. funds only support U.S. researchers and Chinese funds only support Chinese researchers, the collective impact of the funding is amplified because of the CERC collaborative efforts. CERC avoids cross-border duplication and leverages shared knowledge, accelerating research and development of clean vehicle technologies as the world confronts the global challenge of shifting to a low-carbon future.

On the U.S. side, industrial partners are playing a more active role in guiding the research activities. In addition, U.S. industrial partners are participating more actively in discussions with Chinese academic partners as well. This is allowing U.S. industrial partners to reap more benefits from the partnership compared to the Chinese partners.

4. How has each side invested human, technological, and financial resources in the bilateral clean energy cooperation programs? What are the major government and nongovernmental actors on each side? What are their respective objectives and goals for the clean energy partnership?

Investments have been made to support basic research, with funding going predominantly to graduate students and researchers at the partner institutions. The key government actors are the Department of Energy in the US and the Ministry of Science and Technology in China. The goals of the DOE and MOST are to build foundational knowledge, develop technologies, and develop human resources to achieve a future with very low energy intensity. The research work in the US side are done in three universities (University of Michigan, Ohio State University, and MIT) and to a small extent in two DOE labs (Oakridge and Sandia). On the Chinese side, ten universities participated: Tsinghua University, Shanghai Jiaotong University, Beijing Institute of Technology, Tongji University. Tianjin University, Wuhan Institute of Technology, Chinese Academy of Science, Beihang University, Hunan University, and North China Electric Power University.

5. How are the costs of the programs allocated among the governments and companies?

The 2.5M per year funding from the US department of energy is matched 50/50 by the academic and industrial participants. On the Chinese side, there is no matching requirement. The industrial partners only provide guidance and in-kind contribution. They are not providing any financial contribution to the Chinese program.

6. What steps has the U.S. side taken to ensure protection of U.S. intellectual property utilized in cooperative programs?

CERC includes a framework for protecting and sharing intellectual property that provides a strong foundation for U.S.-China clean energy cooperation. The framework enables research partners to share information with confidence and to retain appropriate rights for new technologies they create. Research partners can share the benefits of breakthroughs according to IP agreements established before work begins and extend those benefits by entering traditional commercial contracts to set the terms and to allocate their rights to—and royalties from—their creations.

The clean vehicle consortium is somewhat different from the other two CERCs (clean coal, and building energy), in the sense that the automotive industry is highly competitive and the US funding model requires pooled membership to jointly support research. As such, much of the research work, especially those with close Chinese collaboration is pre-competitive. In addition, all projects that are supported by (US) industrial membership fee are US-only and do not have Chinese collaborators.

7. The Commission is mandated to make policy recommendations to Congress based on its hearings and other research. What are your recommendations for congressional action related to the topic of your testimony?

Excessive carbon emission is a primary contributing factor to climate change--which is one of the biggest challenges we face today. Continue to collaborate on clean energy research, especially on pre-competitive and basic research topics, can be beneficial to both US and China through leveraging, collaborative innovation, and sharing of knowledge.

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U.S.-China Clean Energy Research Center Clean Vehicle Consortium (CVC)

Huei Peng

US Director, University of Michigan

UNIVERSITY OF MICHIGAN

TSINGHUA UNIVERSITY 1911

MIT Massachusetts Institute of Technology

OAK RIDGE National Laboratory

Sandia National Laboratories

Argonne NATIONAL LABORATORY

jbei Joint BioEnergy Institute

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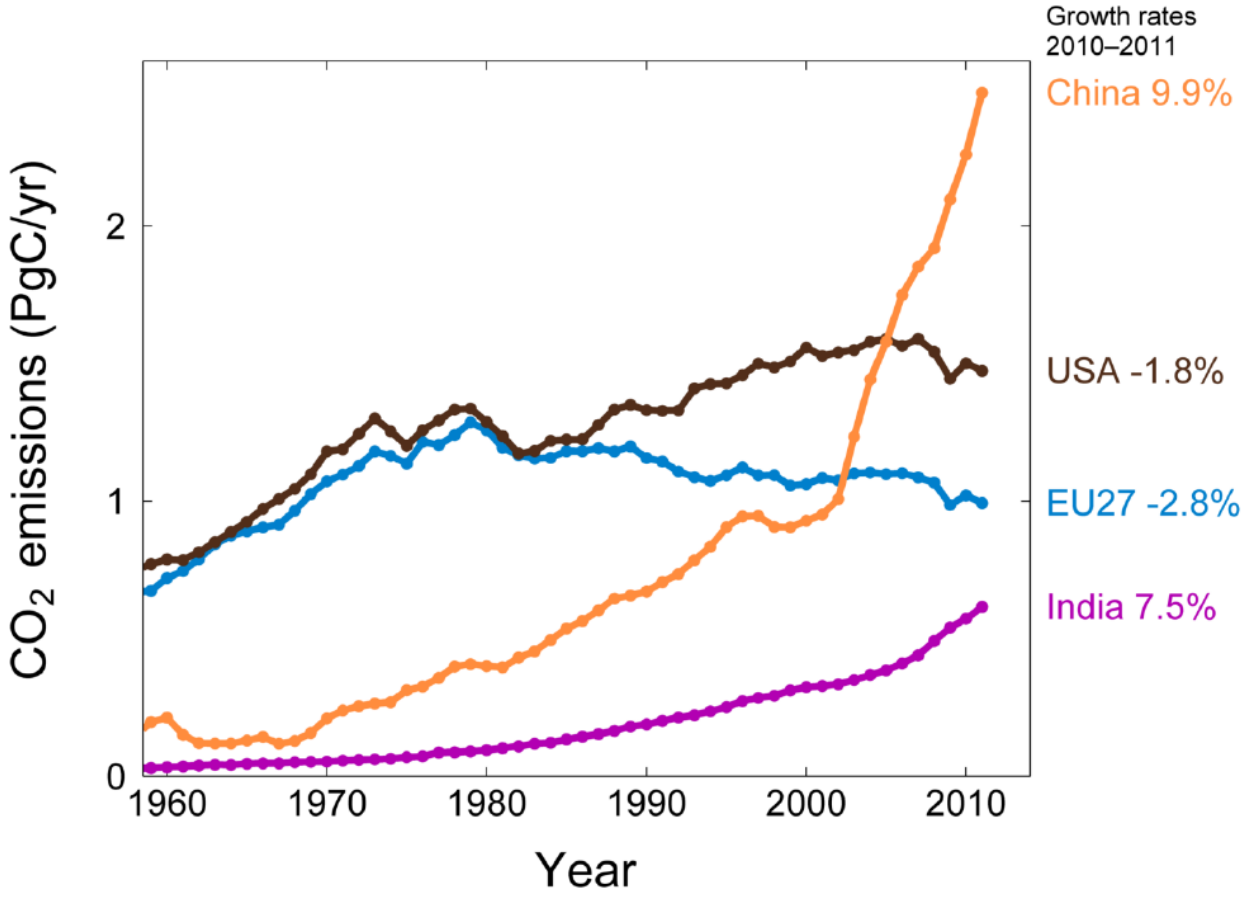
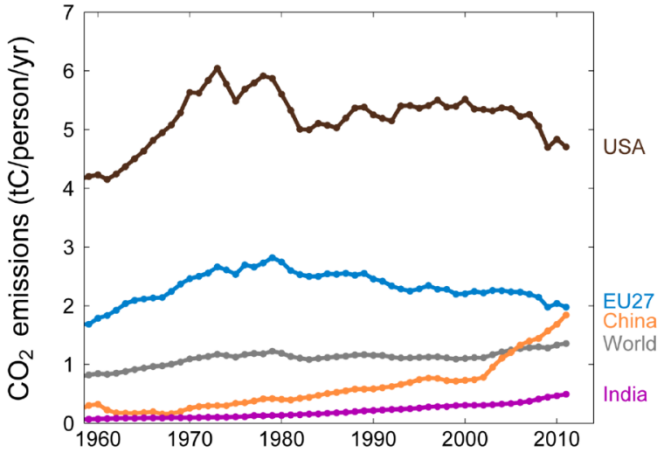
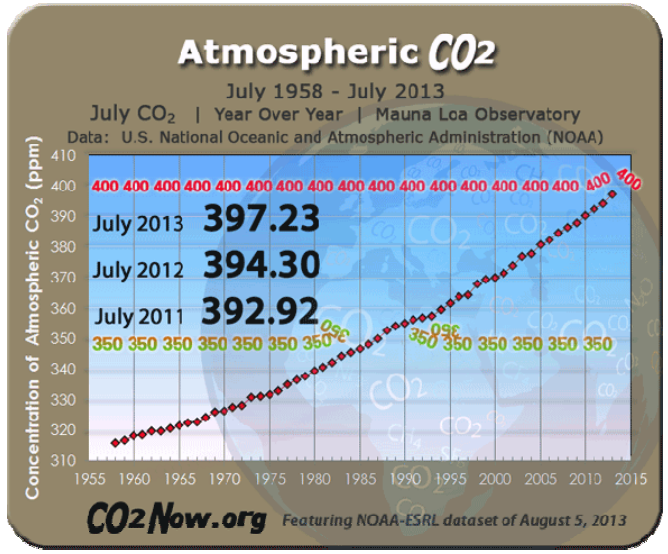
Motivation of CERC

Top four emitters in 2011 covered 62% of global emissions

China (28%), United States (16%), EU27 (11%), India (7%)







Plots from Global Carbon Project report 2012

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US-China Collaboration

Seven Joint Clean Energy Initiatives (2009)

- Electric Vehicles Initiative
- Energy Efficiency Action Plan
- Renewable Energy Partnership
- 21st Century Coal
- Shale Gas Resource Initiative
- Energy Cooperation Program
- U.S.-China Clean Energy Research Center

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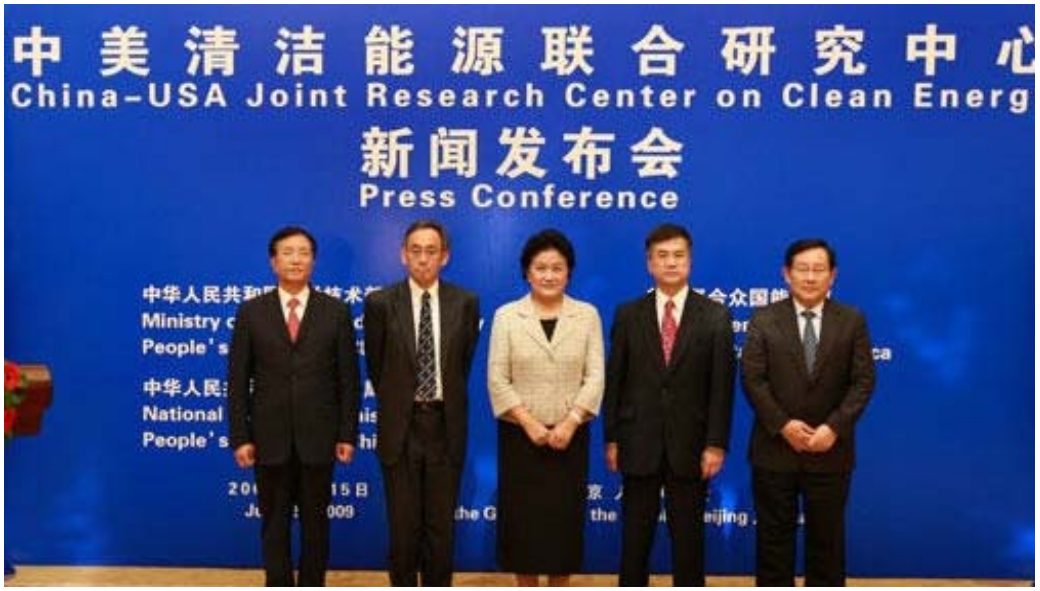
Establishing Three CERCs

US-China Strategic Forum on Clean Energy Cooperation, January 18, 2011



Clean Vehicles

Building Energy

Clean Coal

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CERC Leadership

	Coal		Vehicles		Buildings	
U.S.	WVU	Director Dr Jerald J Fletcher	UM	Director Prof Huei PENG	LBNL	Director Dr Nan Zhou
	LLNL	Tech Pgm. Mgr. Dr Julio Friedmann	UM	Deputy Director Prof Jun NI (Research)	LBNL	Deputy Director Dr YAO Yuan
	WVU	Collaboration Mgr Dr SUN Quingun	UM	China Liaison Professors PENG & NI	LBNL	Advisor Dr Mark Levine
	WVU	Operations Manager Sam Taylor	UM	Operations Manager Carrie Morton	LBNL	Operations Manager Brian Heimberg
China	HUST	Director Dr ZHENG Chugang	Tsinghua	Director Dr OUYANG Minggao	MOHURD	Director Dr LIANG Junqiang
	Huaneng CERI	Chief Engineer Dr XU Shisen	Tsinghua	Deputy Director Dr WANG Hewu	Tsinghua MOHURD	Tech Pgm. Mgr. Dr JIANG Yi
	Tsinghua	Chief Scientist Dr YAO Qiang	Tsinghua	Deputy Director Dr QIU Xinping	MOHURD	Deputy Director Dr LIU Younong

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CERC-CVC Funding Summary (US Side)

DOE Funding: $2.5M/year for 5 years

- Approx. 25 research project tasks; more than 20 faculty and 20 graduate students at UM and partner schools and national labs

University + Industry Funding: >$2.5M/year for 5 years

- Additional research projects
- In-kind support for CERC-CVC test beds
- Support for center administration and collaboration
  - Full time manager
    - Full-time consortium manager & administrative support
    - Travel for consortium members to enhance collaboration with Chinese partners

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Academic & National Lab Partners

U.S.

China

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Industrial Partners

U.S.

Ford DELPHI DENSO EATON

TOYOTA HONDA pjm TE connectivity Aramco Services Company

China

SAIC GEELY JAC CAERI CATARC GM

LISHEN Potevio JJE ECTEK KeyPower 科易动力

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CERC in the US-China Clean Vehicle Research Eco-system

U.S. DEPARTMENT OF ENERGY

International Affairs

国际合作司 (International Affairs)

Oversight

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
Vehicle Technology Office

U.S. DEPARTMENT OF ENERGY
Office of Science
Basic Energy Sciences

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U.S.–China Clean Energy Research Center

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高新技术发展及产业化司 (Advanced Technology division)
863 projects

基础研究司 (basic research division)
973 projects

Ford
DELPHI
DENSO
EATON
arpa·e

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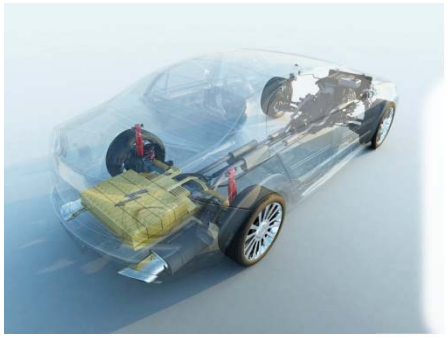
CERC-CVC Thrust Areas

1. Advanced Batteries and Energy Conversion

4. Lightweight Structures

2. Advanced Biofuels, Clean Combustion and APU

5. Vehicle-Grid Integration



3. Vehicle Electrification

6. Energy Systems Analysis, Technology Roadmaps and Policies

24 Projects

1	1	2	OSU-Canova	In-situ Neutron Depth Profiling of Lithium Ion Battery Materials for Improved Electrochemical Performance and Aging Models	Cooperative (US)
1	1	3	SNL-Leung	Li-ion Battery Aging and Internal Degradation Mechanisms	Cooperative (US)
1	1	4	ORNL-Feng	Understanding the Performance and Reliability of Large Format Li-Ion Batteries through In-situ Time-resolved Neutron Diffraction 3D Mapping	Cooperative (US)
1	2		UM/MIT	New Battery Chemistries	Joint
1	2	1	UM-Siegel	High Energy Density Battery Chemistries	Joint
1	2	2	MIT-Yang	Fundamental Understanding of Li-Air Reaction Mechanisms	Cooperative (US)
1	3		THU-Lu	Modeling and Control of Lithium-Ion Batteries	Cooperative (China)
Thrust 2: Advanced Biofuels, Clean Combustion and Auxiliary Power Unit (APU)					
2	1		UM/ORNL/SNL	Advanced Biofuels	Joint
2	1	1	SNL-Simmons	Biofuel Chemistry & Physics	Joint
2	1	2	UM-Violi	Chemical and Physical Models for Novel Fuels	Cooperative (US)
2	1	3	ORNL-Szybist	In-Cylinder Biofuel Combustion Behavior	Joint
2	2		OSU-Wang	Integrated Powertrain and Aftertreatment System Control for Clean Vehicles	Joint
2	3		THU/SJTU	Auxiliary Power Unit	Cooperative (China)
2	3	1	SJTU-Xu	Development of APU Oriented Boxer Engine	Cooperative (China)
2	3	2	SJTU-Wang	APU Oriented High Efficiency and Clean Combustion System	Cooperative (China)
2	3	3	THU-Yang	Integration and Systematic Control of APU system	Cooperative (China)
2	4		UM-Uher	Energy Conversion	Joint
Thrust 3: Vehicle Electrification					
3	1		UM-Hofmann	Efficient and High Power Density Electric Powertrain	Joint
3	2		THU-Li	Control and Optimization of Distributed Vehicle Network	Cooperative (China)
3	3		UM/OSU	System Integration Technologies for Improved Efficiency, Safety, Reliability and NVH Performance	Joint
3	3	1	UM-Peng, Sun	Rapid System Integration Through Modular Configuration, Sizing and Control	Joint
3	3	2	OSU-Rizzoni	Intelligent Fault Diagnosis and Prognosis	Joint
3	4		UM-Stein	Battery Modeling and Control	Joint
3	4	1	Peng/Sun	Adaptive battery management system on and off the grid	Joint
3	4	2	Bernstein & Stein	Data-Based Techniques for Battery-Health Prediction	Cooperative (US)
Thrust 4: Advanced Lightweight Materials and Structures					
4	1		SJTU	Forming processes for lightweight materials	Joint
4	2		Liu	Cost effective lightweight materials	Cooperative (US)
4	3		UM/OSU	Joining in Multi-Material Vehicle Structures	Joint

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24 Projects

Thrust 4: Advanced Lightweight Materials and Structures					
4	1		SJTU-Liu	Forming Processes for Lightweight Materials	Joint
4	2		OSU-Castro	Cost Effective Lightweight Materials	Cooperative (US)
4	3		UM/OSU	Joining in Multi-Material Vehicle Structures	Joint
4	3	1	OSU-Bhushan	Dynamic Characterization of Spot Welds for Advanced High Strength Steel	Joint
4	3	2	OSU-Daehn	Conformal Interference Joining	Cooperative (US)
4	3	3	UM-Ni	Friction Stir Welding of Dissimilar Metals	Joint
4	3	4	UM-Thouless	Hybrid Materials Interface Increased Strength Method and Modeling	Cooperative (US)
4	4		UM-Saitou	Multi-Material Lightweight Body Subsystem & Vehicle Optimization	Joint
Thrust 5: Vehicle Grid Integration					
5	1		THU/OSU	Information Grid for Electrified Vehicles	Joint
5	1	1	THU-Li	System Architecture and Interaction Mechanism of ITS based V2G	Joint
5	1	2	THU-Li	EV Intelligent Control Based on Vehicle-Grid-Infrastructure Interaction	Joint
5	2		OSU-Sioshansi	Vehicle-Grid System Modeling for Technology Deployment	Joint
5	3		UM-Hiskens	Control Strategies for Vehicle-Grid Integration	Joint
5	4		UM-Mi	A Wireless Magnetic-Resonance Power Transmission System for EV Charging	Cooperative (US)
Thrust 6: Energy Systems Analysis, Technology Roadmaps and Policy					
6	1		UM-Keoleian	Set CV Technology Energy Efficiency and GHG Targets and Evaluate Life Cycle Performance	Joint
6	2		SNL/UM	Fuel Mix Strategies and Constraints	Cooperative (US)
6	2	1	SNL-Manley	Parametric Analysis of Biofuels in the Light Duty Fleet	Cooperative (US)
6	2	2	UM-Xu	Fuel Mix Strategies and Constraints	Cooperative (US)
6	3		UM-Kelly	Fuel Economy and GHG Standards and Labels for PEVs from a Life Cycle Perspective	Joint
6	4		MIT/UM	CV Technology Roadmap and Policy Recommendations	Cooperative (US)
6	4	1	MIT-Heywood	Fleet Modeling on China's In-use Vehicle Fleet	Cooperative (US)
6	4	2	UM-DeCicco	Roadmapping Model Development	Cooperative (US)
6	5		UM-Kelly	Electricity and Material Sourcing Scenario Analyses to Guide Vehicle Technology Strategies	Cooperative (US)

Cooperative (US)	5
Joint	16
Cooperative (China)	3
	24

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Leverage Opportunities for the US

	US	China
Battery research	Li-air; Emphasis on modeling; Degradation of LFP batteries	Lithium Sulfur; Emphasis on experiments; Degradation of LMO batteries
Powertrain type	All electrified vehicles—including hybrid powertrain	Largely focus on Pure electric
ICE research topics	Biofuels and clean combustion	APU as range extenders
"Grid"	Electricity grid	Electricity and information grids
Electric machine and power electronics	Advanced design and simulation tools	Produce an efficient prototype
Thermo electric material	World-leading theories and models leading to new TE concepts	Excellent facilities and focus on demonstration
Funding leverage	Industrial partners	MOST 863, 973 projects

Differences in US/Chinese markets and R&D inspire complementary research ideas and results.

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Long-Term Outlook

Year 5
Year 4
Year 3
Year 2
Year 1

Processes & Products

Patents

Papers

Impact to practice

Knowledge generation

Team building

People